

Successful brace treatment of Scheuermann's kyphosis with different angles

ABSTRACT

Background: Scheuermann's disease is regarded as the most common cause of structural hyperkyphosis within adolescents without any proper treatment. It may lead to progressive deformity and back pain which influences patient's quality of life during adolescence and adulthood. Treatment approach to Scheuermann's kyphosis has not been clearly defined due to its different definitions and obscure natural history. The goal of treatment is not only to prevent progression but also to obtain permanent correction. Bracing, especially Milwaukee brace and physiotherapy are two of the common nonoperative treatment modalities. Hence, the present study intended to evaluate the effectiveness of Milwaukee brace on progression control as well as correction of Scheuermann's kyphosis.

Materials and Methods: In a retrospective, observational study, all the patients diagnosed with Scheuermann's kyphosis were reviewed in 2003–2013, who were treated by Milwaukee brace at a single center. There was a minimum of 2-year follow-up after completion of bracing, during which clinical and radiological parameters were identified and recorded.

Results: The mean angle of kyphosis in these patients at the presentation was 63.24 ± 9.96 and at the end of this study was 36.5 ± 13.4 ($P < 0.001$). Moreover, mean improved angle in those patients with $<75^\circ$ of kyphosis was 25.26 ± 7.78 and in those with 75° or more than 75° of kyphosis was 26.77 ± 19.76 ($P < 0.001$).

Conclusion: Conservative treatment with Milwaukee brace and physiotherapy was effective in our hand for halting kyphosis progression in 97.5% of Scheuermann's kyphosis, which could be advised for cases up to 90° of kyphosis before skeletal maturity. As a result, a trial of brace treatment could be recommended in patients with severe kyphosis (up to 90°) which can open a new insight in conservative treatment of Scheuermann's kyphosis.

Keywords: Milwaukee brace, Scheuermann's kyphosis, treatment

INTRODUCTION

Scheuermann's disease is an idiopathic structural sagittal plane deformity that develops during the adolescence. It was first described by Scheuermann in 1920 as a different disorder from postural kyphosis on the basis of spine rigidity.^[1,2] Although the exact cause of deformity is unknown, it may have a multifactorial etiology. The etiology is thought to be a development error in collagen aggregation, leading to disturbance of the endochondral ossification of anterior vertebral end plates.^[2,3] This causes wedging of the vertebrae as well as increasing of kyphosis.^[4,5] Genetic, hormonal, and mechanical etiology has been discussed, and an autosomal dominant pattern of inheritance has been proposed as

an etiologic factor. Although incidence of this disease is unknown, approximately 1%–8% of general population is involved.^[5-7]

The classical radiologic findings of Scheuermann's kyphosis encompass wedging of three consecutive vertebrae (more than 5°), end plate irregularity, and loss of disc

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space height, Schmorl's nodes (in some cases) and anterior detachment of epiphyseal ring as outlined by Sorenson.^[2,8,9]

The natural history of Scheuermann's kyphosis has not been clearly defined and kyphosis of $>65^\circ$ may continue to increase even after the skeletal maturity.^[5,10] Furthermore, untreated kyphosis in growing child may lead to a progressive deformity of the spine as well as back pain and neurologic deficit.^[8,11,12] Considerable controversy has been observed regarding optimal treatment of Scheuermann's kyphosis. Hence, the treatment of Scheuermann's kyphosis during adolescence should be mainly taken into account as an attempt to prevent problems during adulthood for halting the curve progression. Conservative treatment through cast and brace was developed in parallel to that of scoliosis 60 years ago.^[10,11,13] The use of Milwaukee brace was first reported by Moe in 1965.^[14,15]

The aims of treatment in Scheuermann's kyphosis are prevention of curve progression, deformity correction, pain relief, and cosmetic concern.^[4,14,15]

Treatment with braces such as Milwaukee is effective only in that patient who is still growing.^[9,12]

Milwaukee brace is a cervico-thoraco-lumbo-sacral orthosis initially developed by Walter Blount and Albert Schmitt in Milwaukee city in the US. It is widely applied to treat Scheuermann's kyphosis in adolescents [Figure 1]. It typically comprises pelvic girdle (pelvic mold), bars (superstructures), and combination of corrective sling and pads that attach to the superstructure.^[9,11]

This brace has a symmetrical design with a posterior opening. Corrective forces may consist of both passive and active mechanisms. Pelvic girdle was fabricated from



Figure 1: Milwaukee brace

low-temperature thermoplastics that lock intimately onto the waist roll and reduced lumbar lordosis since it was theorized that this can allow for kyphosis correction and spine mobility. Few studies have evaluated the effects of Milwaukee on Scheuermann's kyphosis treatment.

The studies carried out so far demonstrate that wearing a brace changes the natural history of kyphosis and probably assists the patient in avoiding the surgery, specifically when the brace meets the current quality standards.^[5,11,12]

Therefore, the present study aimed to estimate the effectiveness of the brace on stopping the progression and treatment of Scheuermann's kyphosis.

To the best of our knowledge, this is the first report within the past 20 years examining the effect of bracing on Scheuermann's kyphosis with a 2-year follow-up.

MATERIALS AND METHODS

In this retrospective clinical study, ethical approval was obtained from Ethics Committee of Isfahan University of Medical Sciences following the Institutional Review Board approval.

Within 2003–2013, 148 participants diagnosed as Scheuermann's kyphosis who met the criteria for inclusion and who were treated by Milwaukee brace as well as physiotherapy were studied retrospectively [Figure 1]. The criteria regarding diagnosis of typical Scheuermann's kyphosis are rigid thoracic kyphosis of more 45° and wedging more of than 5° at least three adjacent vertebrae at apex of kyphosis and vertebral end plate irregularities. Some cases with structural kyphosis deformity but no typical finding of wedging or end plate irregularities were also included in the present study. Therefore, inclusion criteria for hyperkyphotic participants were as follows: (1) document diagnosis of Scheuermann's kyphosis, (2) Cobb's angle between 45° and 90° , (3) Milwaukee brace prescription, (4) no other known musculoskeletal disorder, and (5) no previous brace treatment and Risser 4 or more. All the study data were collected at the time of each visit. Standing anterior-posterior and lateral radiographs were taken at the initial visits. Normally, Cobb's angle was measured from T2 to T12 in thoracic kyphosis and T10 to L2 for thoracolumbar kyphosis. At the first office visit after brace wearing, a standing lateral radiography was taken in regard with the brace to assess the percentage of curve correction and necessary adjustments.

Patients were visited at 6-month intervals with lateral X-ray in brace. The required information including age, sex,

menstrual history, lateral X-ray in brace, and eventually total time in brace were recorded every 6 months. As a matter of fact, bracing was continued for at least 18 months or until growth completion measured by Risser 4 on X-ray of the pelvis or until 2 years after regular menses. Bracing was considered successful if there was $\leq 5^\circ$ of progression and to have failed if there was $> 5^\circ$ of progression or if surgery was performed. Scoliosis Research Society (SRS) questionnaire was filled before and after the treatment completion. Success and failure were measured and analyzed in regard with age, curve size, menarche status, Risser sign, and complication. The measurements and evaluations were performed by the principle author (ME).

The current study sample was collected through convenience sampling method and the sample size was calculated as 111 patients based on the sample size calculation formula for comparison of means with confidence level of 95%, test power of 80%, and the variance of kyphosis angle about 1.5° and the minimal clinical significant difference between before and after intervention of 0.4 (40%) between before and after the intervention and finally 120 patients were studied.

Out of 148 cases, only 120 patients who obtained the inclusion criteria were selected and asked to participate in this study. Reasons for dropouts were loss of motivation to follow-up measurement ($n = 25$) and decision for surgery ($n = 3$).

In the present study, a low-profile brace without a chin ring and anterior shoulder pads was applied concerning the curves with an apex at the level of T9 or lower. An extensive physical exercise program accompanied brace treatment including pelvic tilt (exercise to reduce lumbar lordosis), trunk extensor strengthening and hamstring, and pectoral stretching exercises two times a day.

The patients also completed SRS-22 questionnaire comprising five domains: (1) covering function/activity (5 questions), (2) pain (5 questions), (3) self-image (5 questions), and (4) mental health (5 questions) and satisfaction with management (2 questions). It is worth mentioning that these data have not been stated in this report because the data are subjective and do not, as such, contribute to anything of scientific value.

To statically analyze the study data, the PASW statistic 18 package (SPSS Inc., Chicago, IL, USA) was utilized through applying independent sample *t*-test and paired sample *t*-test. Moreover, descriptive statistical analysis was used including means, standard deviation, with 95% of confidence interval which the alpha was set at 0.05.

RESULTS

The mean age of patients during admission was 12.08 ± 1.9 (range: 10–17). Forty-three (35.8%) of the patients were male and 77 (64.2%) were female, whose mean age was reported 12.26 ± 1.7 and 11.97 ± 1.9 , respectively, and no significant difference was observed between males and females ($P = 0.41$) in regard with their age. Location of kyphosis was thoracic in 110 cases (91.7%) and thoracolumbar in 10 cases (8.3%). Furthermore, 16 (3.13%) patients in addition to kyphosis were also affected by scoliosis with the mean scoliosis angle of $20.44^\circ \pm 8.58^\circ$ though one patient progressed to 35° scoliosis after the brace treatment. The main complaint of the patients involved deformity in 105 cases (87.5%), deformity with pain in 11 cases (9.2%), and just pain in 4 cases (3.3%). Furthermore, a significant difference was demonstrated regarding the main complaint of patients in thoracic and thoracolumbar groups, whereas the other variables did not differ significantly between the mentioned groups [Table 1].

Mean initial angle of kyphosis in patients with thoracic kyphosis was reported $63.24^\circ \pm 9.96^\circ$ with the range of 47° – 90° . In 96 patients (80%), angle of kyphosis was less 75° , whereas in 22 patients (20%), it was observed to be a 75° or higher than 75° . Brace was prescribed for these patients, and thus, they were under medical follow-up since the prescription. The mean duration of follow-up of these patients was 30.22 ± 7.5 months, ranging from 24 to 50 months. Follow-up duration for patients was reported as follows: 24 months in 43 patients (35.8%), 25–36 months in 47 patients (39.2%), and above 36 months in 30 patients (25%). The mean duration of brace wearing in these patients was 22.9 ± 9.48 months ranging from 12 to 48 months so that 22 patients (18.3%) wore braces for 12 months, 26 patients (21.7%) for 12–18 months, 25 patients (20.8%) for 18–24 months, 36 patients (30%) for 24–36 months, and 11 patients (9.2%) for more than 36 months (maximum 40 months) [Table 1].

Paired *t*-test showed a statistically significant difference between the mean of initial kyphosis and the end kyphosis angles (60.86 ± 12.99 vs. 36.49 ± 13.38) ($P < 0.001$).

The modified angle was equaled to 24.93 ± 11.28 , so it was significantly more improved in thoracic kyphosis angle with the mean of 25.56 ± 11.12 than thoracolumbar kyphosis angle (18.00 ± 11.14) ($P < 0.05$) [Table 2].

Comparing the modified angle of kyphosis based on the severity showed that the mean of modified angle in the patients with initial angle of $> 75^\circ$ was 24.96 ± 7.82 and

Table 1: Distribution of basic and clinical characteristics of patients

Variable	Total	Thoracic (n=110)	Thoracolumbar (n=10)	P*
Age (year)	12.08±1.85	12.02±1.9	12.7±1.7	0.27
Sex				
Male	43 (35.8)	39 (35.5)	4 (40)	0.774
Female	77 (64.2)	71 (64.5)	6 (60)	
Main complain				
Deformity	105 (87.5)	102 (92.7)	3 (30)	<0.0001
Deformity and pain	11 (9.2)	7 (6.4)	4 (40)	
Pain	4 (3.3)	1 (0.9)	3 (30)	
Scoliosis				
Yes	16 (13.3)	14 (12.7)	2 (20)	0.621
No	104 (86.7)	96 (87.3)	8 (80)	
Initial angle of kyphosis				
<75	96 (80)	88 (80)	8 (80)	0.999
≥75	24 (20)	22 (20)	2 (20)	
Surgery				
Yes	3 (2.5)	2 (1.8)	1 (10)	0.232
No	117 (97.5)	108 (98.2)	9 (90)	
Duration of brace wearing (month)	22.92±9.48	23.39±9.59	17.70±6.46	0.069
Follow-up (month)	30.22±7.46	30.55±7.60	26.60±4.55	0.109

*Compared two groups thoracic and thoracolumbar

Table 2: Comparison the mean of modified kyphosis angle (initial, end, and modified) by the type of kyphosis

Kyphotic angle	Total	Thoracic (n=110)	Thoracolumbar (n=10)	P*
Initial angle	60.86±12.99	63.24±9.96	34.70±14.16	<0.001
End angle	36.49±13.38	38.09±11.86	18.90±16.97	0.002
Correction angle	24.93±11.28	25.56±11.12	18.00±11.14	0.029

*Compared two groups thoracic and thoracolumbar

it was 24.79 ± 20.14 in the initial angle of $\leq 75^\circ$ with a statistically significant difference between the two groups ($P > 0.05$); in other words, the mean of modified angle in severe kyphosis was the same as mild kyphosis.

However, type-based evaluations revealed that in thoracic kyphosis, there was no difference between the two kinds of kyphosis ($>75^\circ$ or $\leq 75^\circ$), whereas in thoracolumbar kyphosis, the mean of modified angle in the initial angles of $<75^\circ$ was 21.75 ± 8.08 that was significantly more than the mean of modified angle in the initial angles of $\geq 75^\circ$ with the value of 3 ± 9.90 ($P = 0.044$).

In fact, it seems that the type of kyphosis can be effective in modifiability of kyphosis angle as wearing the brace in severe and mild angles of thoracic kyphosis would be effective in a same rate, but it can be effective only in the angles of $>75^\circ$ in thoracolumbar kyphosis [Figure 2].

Table 3 compares the mean of modified angle in general and by the initial angles in terms of demographic and clinical features. Mean of improved angle was significantly

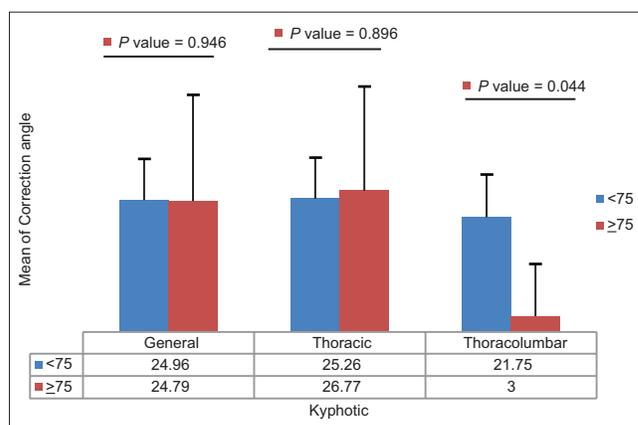


Figure 2: Bar graph showing comparison of the mean modified angle by the type and severity of kyphosis

modified by the patients' age ($P < 0.001$) in a way that as the age increases, the angle is less refined. Furthermore, the improved angle correlated with the mean duration of brace wearing. In other words, the mean improved angle increased as the duration of wearing the brace increased. However, the patients' main complaint was not associated with the modified angle.

The type of kyphosis had an effective role in the rate of modified angle as the mean of modified angles in thoracic kyphosis and thoracolumbar kyphosis was 25.56 ± 11.13 and 18.00 ± 11.14 , respectively ($P = 0.029$). However, separately evaluating of kyphosis in the both kinds of mild ($<75^\circ$) and severe (more than 75°) found no significant difference between these two types ($P > 0.05$) [Figures 3 and 4].

Table 3: Comparing of improved angle considering the patients' characteristics based on initial angle of kyphosis

Variable	Corrected angle					
	Total	P	≤75	P	>75	P
Age group						
10-12	30.4±8.8	<0.0001	28.20±5.67	<0.0001	45.00±11.81	<0.0001
13-14	17.9±7.2		17.87±7.23		-	
≥15	10.4±9.1		-		10.3±9.08	
Sex						
Male	24.84±10	0.951	25.03±8.20	0.921	24.00±16.48	0.881
Female	24.99±12		24.93±7.66		25.18±22.24	
Main complaint						
Deformity	25.29±11.45	0.450	24.90±7.96	0.981	26.81±20.39	0.161
Deformity and pain	20.91±10.15		24.75±6.18		10.67±12.86	
Pain	26.75±9.43		26.75±9.42		-	
Duration of brace wearing (months)						
12	12±9.5	<0.0001	15.58±8.85	<0.0001	7.70±8.76	<0.0001
13-18	20.23±6.03		20.75±5.62		14.00±9.89	
19-24	25.12±5.12		25.33±5.11		20.00±0.00	
25-36	31.81±7		30.41±5.54		37.57±9.88	
>36	39±14.26		31.71±3.98		51.75±15.56	
Scoliosis						
Yes	26.94±14.26	0.451	28.45±11.45	0.116	23.60±20.37	0.886
No	24.63±10.8		24.51±7.19		25.10±20.63	
Kyphosis						
Thoracic	25.56±11.13	0.029	25.26±7.77	0.100	26.77±19.75	0.116
Thoracolumbar	18.00±11.14		21.75±8.08		3.00±9.90	
Follow-up (years)						
≤2	8.81±1.341	<0.0001	19.88±6.77	<0.0001	8.33±9.97	<0.0001
3	7.290±1.06		25.10±6.49		16.66±8.80	
>4	9.44±1.72		32.95±4.44		46.66±11.21	
Surgery						
Yes	-1.33±2.31	<0.0001	-	-	-1.33±2.31	0.002
No	25.61±10.59		24.97±7.82		28.52±18.68	

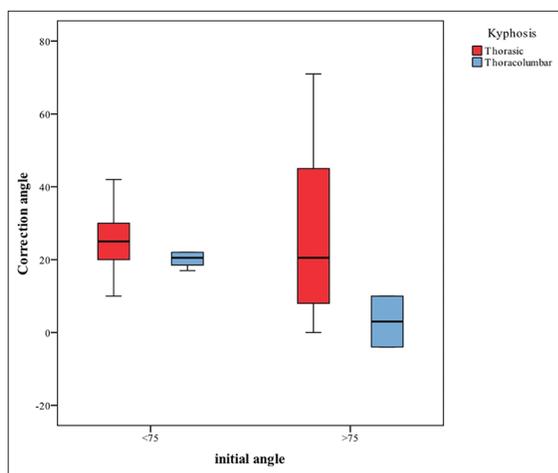


Figure 3: Box plot mean of correction angle based on initial angle and type of kyphosis

On the other hand, according to *t*-test results, there was no significant correlation between the mean of improved angle based on patient's sex and scoliosis presence ($P > 0.05$) [Table 3].

In the present study, 15 patients aged above 15 years that 9 patients were female and 5 were male that Risser sign was shown to be above 3. The primary mean angle of kyphosis was $59.1^\circ \pm 17.1^\circ$ before bracing and $50.1^\circ \pm 22^\circ$ after bracing. The mean of correction angle was 13.14 ± 9.6 , which the minimal clinically significant difference was not optimum.

As a matter of fact, complication has occurred in five patients due to bursa and skin irritation, which were resolved with the brace modification.

DISCUSSION

The aim of the current study was to evaluate the brace effectiveness on progression control and correction of kyphosis as well as to evaluate the hypothesis that brace would have an effect on Scheuermann's kyphosis in patients near skeletal maturity and in severe kyphosis.

According to study results, the mean angle of kyphosis in these patients at the presentation was 63.24 ± 9.96 and at the

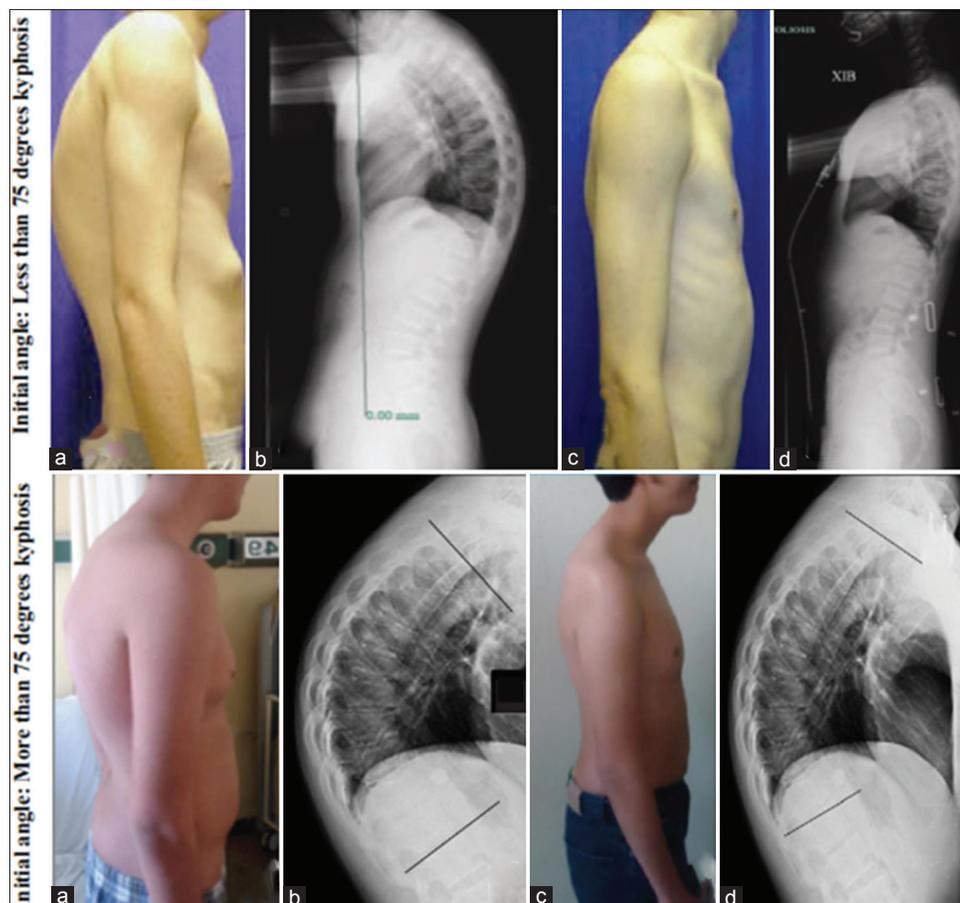


Figure 4: (a) Prebracing photo, (b) Prebracing radiography, (c) Postbracing, and (d) Postbracing radiography base on initial angle (<75° or ≥75°)

end of the study was $36.5 \pm 13.4^\circ$, which the difference was quite significant both before and after treatment ($P < 0.001$). The improvement in kyphotic angle was $24.93^\circ \pm 11.28^\circ$, and three patients (2.5%) were referred to the surgery due to lack of improvement during treatment [Figure 4].

Scant evidence has been proposed in regard with natural history of untreated Scheuermann's kyphosis. According to a study conducted by Ristolainen *et al.* on untreated Scheuermann's kyphosis with a 37-year follow-up, higher risk of back pain as well as lower quality of life and general health were reported for Scheuermann's kyphosis patients compared to the control groups.^[13] There are a few reports in the literature concerning the effects of bracing on Scheuermann's kyphosis patients. To the best of our knowledge, this study involves the first report within past 20 years conducted on Scheuermann's kyphosis applying Milwaukee brace.

Those patients who come to medical attention typically do so because of their concern about deformity, pain, cosmesis, or neurologic problem (rarely).^[14,15] Although back pain in adult patients with Scheuermann's kyphosis is

often secondary to spondylosis associated with deformity, untreated Scheuermann's kyphosis reveals higher risk of back pain than controls nearly fourfold.^[13,16,17]

Paajanen *et al.* reported that 55% of discs in young adults with Scheuermann's kyphosis were abnormal on MRI. This rate was reported five times more than that of asymptomatic controls.^[16]

In another study, Murray *et al.* investigated the natural history and long-term follow-up of Scheuermann's kyphosis in 1993.^[5] They followed up 67 patients who had a mean kyphotic angle of 71° with an average of 32 years. Patients with Scheuermann's kyphosis rated their back pain as more intense and localized in the thoracic spine. Therefore, these patients were inclined to a higher risk of back pain and disability during their daily activities compared to their age-matched controls.

According to the study results, the average kyphosis decreased from about 63° before treatment to 36° after treatment demonstrating a clinically significant improvement.

Although some correction was lost in a longer follow-up, it was still in an acceptable range and obviated the need for surgery in the most cases.

Average duration of brace wearing was 22.9 ± 9.5 months for a mean of 14 h a day. Correction angle was observed to be directly related with time of brace wearing and to inversely related with age though no correlation was observed with sex.

Bracing has already been recommended for skeletally immature patients with a thoracic curve of $<70^\circ$, whereas surgery has been advised for those patients who have structural kyphosis that is large and cosmetically unacceptable.

Bradford *et al.* reviewed 155 patients with Scheuermann's disease that were treated through Milwaukee brace – reporting average kyphosis decrease from 59° to 39° after 34 months. The present study showed average kyphosis decrease from 63° to 36° after 22 months of treatment through bracing and physiotherapy. This physiotherapy including pelvic tilt (exercises to reduce lumbar lordosis) and thoracic extension programs.^[3,11,12,17]

In the current study, vertebral wedging average of 8° before treatment decreased to about 4° after the brace wearing which was in line with finding of Bradford's report. It is worth mentioning that most patients required full-time brace wear of longer than 18 months to represent this improvement in the vertebral wedging.^[18]

Montgomery and Erwin encompassed part-time bracing with average of 18 h for 18 months in regard with the Scheuermann's treatment. Thirty-nine participants were studied who completed brace wearing. The average curve improved from 62° to 41° .^[9] The findings of the present study revealed that average brace wear was 14 h (6–21 h) for 22.9 months (12–48 months), which corrected kyphosis from 63° to 36° .

Patients usually complained of pain or deformity. In the current study, the most common complaint was deformity (87.5%), whereas pain with deformity was observed in 9.2% of patients and pure pain complaint was reported in 3.3% of patients.

In contrary, Sorenson noted that 50% of his teenage patients had thoracic pain which was decreased to 25% after skeletal maturity. While this pain did not influence the patient's working ability and rarely required any treatment, untreated kyphosis was a source of disabling thoracic pain.^[7]

Murray *et al.* followed 67 patients to document the natural history of Scheuermann's kyphosis. About 9% of patients were unemployed due to the back pain.^[5] They showed that untreated patients suffered from more intense back pain than the general population. However, this pain did not interfere with the type of job and days missed from work.^[5] Normally, Scheuermann's frequency of back pain is typically about 21% though in the atypical Scheuermann's disease (thoracolumbar or lumbar), 80% of patients are observed to be afflicted with pain.^[19]

In another study, Sachs *et al.* studied patients treated by Milwaukee brace some of whom showed a progression of the curve despite the brace treatment. In contrary, only 3 patients (2.5%) did not respond to bracing and were candidates for the surgical correction.^[11] As there is a consensus that surgery is rarely indicated because conservative management is highly effective, it seems necessary to improve the standards of conservative treatment.

Although previous series of Milwaukee brace in Scheuermann's kyphosis suggest a high rate of failure in curves $>75^\circ$, but 22% of curves in this study with prebrace kyphosis of 75° – 90° were treated with brace and exercise and only one patient (4.5%) required surgery due to the kyphosis progression. Average kyphosis correction at the follow-up in this group was reported 95%. The mean of improvement angle in patients whose initial kyphosis angle exceeded 75° and more was 26.77 ± 19.76 and in patients whose initial kyphosis angle was $<75^\circ$ was 25.26 ± 7.78 that the amount of improved kyphosis angle proved to be significantly different ($P < 0.001$) considering the initial angle of kyphosis.

It is believed that 75° – 90° kyphotic curves may be appropriate in regard with Milwaukee brace specifically if kyphosis is flexible. However, more studies with larger samples and long follow-up are recommended. A comprehensive exercise program was applied in these series patients, which was thought to be a significant prophylaxis against the stiffness and weakness induced by wearing the brace.^[18,20]

Patients who were completely compliant had a higher incidence of correction. The present study data suggest that part-time brace wear might be as effective as full brace wear. A prospective study with enough samples in the same condition is clearly needed to address this issue involving both short- and long-term follow-up studies.

We asked to our patients wear brace full time for 23 of 24 h away with extra time out allowed for participation in exercise though almost all patients reported part-time wear of brace.

In fact, the study finding confirmed that as the patient's age reaches skeletal maturity, there may be poor response to treatment with Milwaukee brace.

The strong points of this paper are that all patients were treated by the senior author and only by a Milwaukee brace made by only one experienced brace maker and the large number of patients followed. This study suffers from some limitation. First, it is a purely retrospective, nonblinded study since control group of individuals without kyphosis or with kyphosis who were untreated was inaccessible. Second, some patients were excluded due to lack of follow-up. In addition, thermal monitors were not utilized to objectively measure the compliance with brace wearing. Finally, Milwaukee brace compliance is generally regarded low, therefore making braces with less material and low profile is recommended to improve patients' compliance and quality of life.

CONCLUSION

Milwaukee brace has been proved to be effective in treatment of Scheuermann's kyphosis as well as decrease of the surgery need. In more severe cases (up to 90), brace treatment could be considered, provided there is enough growth remaining. The most common brace used in Scheuermann's kyphosis is Milwaukee brace yet. Furthermore, the earlier an individual starts the brace wearing, the better outcomes will be reached, which highlights the importance of early diagnosis.

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Conflicts of interest

There are no conflicts of interest.

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